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STRACT (Maximum 200 words)

The propagation of electromagnetic beams through the atmosphere is limited by absorption and scattering of electromagnetic waves by air molecules and by particles suspended in the air. Although the theory of electromagnetic interaction with homogeneous spherical particles is well understood, there are still outstanding problems connected to the interaction of electromagnetic radiation with composite or nonspherical particles. Scattering and absorption cross sections of hexagonal prism are derived using the anomalous diffraction approximation. The scattered field of a composite sphere is obtained by solving exactly the vector wave equation.

14. SUBJECT TERMS

Electromagnetic waves, scattering, absorption, resonances, propagation, clouds, snow.

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Interaction of Aerosols and Droplets with Electromagnetic Radiation

Final Report

Petr Chylek

July 26, 1995

U. S. Army Research Office

DAAL03-91-G-0145

The Research Foundation
of the State University of New York

A. STATEMENT OF THE PROBLEM

The propagation of electromagnetic beams through the atmosphere is limited by absorption and scattering of electromagnetic waves by air molecules and by particles suspended in the air. Although the theory of electromagnetic interaction with homogeneous spherical particles is well understood, there are still outstanding problems connected to the interaction of electromagnetic radiation with composite or nonspherical particles. The purpose of the performed research was to enhance the knowledge and computational methods describing interaction of electromagnetic waves with atmospheric particles including nonspherical and composite ones.

B. SUMMARY OF THE MOST IMPORTANT RESULTS

Scattering of electromagnetic waves by nonspherical particles: was considered using the anomalous diffraction approximation. It has been shown that an explicit analytical expressions can be derived for the scattering and absorption cross sections of hexagonal crystals and many other nonspherical shapes. The derived expressions were applied to the case of propagation through cirrus clouds and through the falling snow.

The exact solution of the scattered field by a host sphere containing arbitrarily located spherical inclusion was derived and applied to the case of water droplet containing a black carbon particle. It was shown that effective medium theories provide a good approximation to the effective refractive index of a composite particle.

We have developed a strong research interaction and collaboration with the scientific personnel at the U. S. Army Research Laboratory,

White Sands, NM. The vigorous collaboration is reflected by the fact that four out of eleven publications were co-authored by Dr. R. Pinnick.

We have shown that the positions of resonances of weakly absorbing spheres are different from those of nonabsorbing spheres and that they cannot be characterized by real parts of the positions of poles in the complex plane. Resonances for absorption and scattering does not occur at the same value of the size parameter.

C. LIST OF PUBLICATIONS

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6. P. Chylek and G. Videen: Longwave radiative properties of polydispersed hexagonal ice crystals, Journal of Atmospheric Sciences, 51, 175-190 (1994).

7. P. Damiano and P. Chylek: Shortwave radiative properties of clouds: Numerical study, Journal of Atmospheric Sciences, 51, 1223-1233 (1994).

8. G. Videen, D. Ngo and P. Chylek: Effective medium predictions of absorption by graphitic carbon in water droplets, Optics Letters, 19, 1675-1677 (1994).

9. N. Fujiki, W. Geldart and P. Chylek: Effect of air bubbles on radar backscattering by hailstones, Journal of Applied Meteorology, 33, 304-308 (1994).

10. P. Chylek, P. Damiano, N. Kalyaniwalla and E. Shettle: Radiative properties of water clouds: Simple approximations, Atmospheric Research, 35, 139-156 (1995).

D. PARTICIPATING SCIENTIFIC PERSONNEL

P. Chylek, Principal Investigator

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E. REPORT OF INVENTIONS

None